NOTE XXXV.

THE COMATULAE OF THE LEYDEN MUSEUM.

BY

P. HERBERT CARPENTER, M. A.

The *Comatula*-collection of the Leyden Museum is one of considerable importance, owing to its containing a large proportion of the types of the species described by Johannes Müller in his classical memoir [1]), »Ueber die Gattung *Comatula* Lam. und ihre Arten."

Müller's descriptions, however, are notoriously incomplete, and have undergone no revision since their publication nearly forty jears ago, during which time a very large number of *Comatulae* have been discovered. Some of these have been referred with more or less success to one or other of Müller's species, but without careful comparison with his types no accurate specific determinations have been at all possible. When I visited the Leyden Museum last autumn for the purpose of examining the seven types of Müllerian species which it contains, I was not surprised to find a number of other *Comatulae* in the collection. Thanks to the good offices of my friend Dr. Hubrecht, to whom I am indebted for many acts of kindness, the whole of the foreign *Comatula*-collection numbering twenty-five specimens was sent over to my laboratory at Eton, in order that I might study it in more detail than was pos-

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1) Abhandl. d. Berlin. Akad. 1849. pp. 237—265.

sible during a short visit to the Museum. For this act of liberality on the part of the Director, Dr. Schlegel, I would here express my heartiest thanks.

Besides *Antedon rosacea* and *Ant. Eschrichtii* of the European seas, the collection includes ten species of *Antedon* from the Eastern seas. Two of these, *Ant. elongata*, and *Ant. flagellata* are the original types of Müllerian species; while a third belongs to *Ant. carinata* Lam. sp., the types of which are at Paris and Berlin. The remaining seven species are new, though they present but little variety of type. Four of them have only ten arms, and the other six all belong to one simple type in which the rays divide three or four times, each division consisting of two joints, the axillary without a syzygy.

The genus *Actinometra* is represented by a type specimen of *Act. solaris* Müll. which seems to have been subsequently described and figured as *Comatula hamata* by Kuhl and van Hasselt[1]). There are also nine other species including the types of *C. timorensis*, *C. japonica*, *C. Novae Guineae* and *C. Bennetti* all of which, except the last, are now referred to the genus *Actinometra* for the first time. Simple ten-armed forms with the two outer radials not united by syzygy as they are in *Act. solaris*, are conspicuous by their absence, as is usual among the *Actinometrae* of the Eastern Seas; but in every type the rays divide more than once and the first division consists of three joints, the axillary with a syzygy. In two of the nine species there is no further division of the rays, while the remaining seven fall into two groups. In the one group which includes but two species, the second and subsequent ray-divisions consist of two joints only which are united by a syzygy, as are also the second and third radials: while in four of the five remaining species the second and

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1) Herklots, J. A., Echinodermes peintes d'après nature par les soins de Kuhl, van Hasselt et Sal. Müller (1868), Amsterdam. Bijdrage tot de Dierkunde, IX, 1869, p. 10, Pl. IX.

subsequent ray divisions all resemble the first. The fifth species is peculiar; the third and fifth divisions resemble the first, but the second and fourth consist of only two joints without a syzygy.

The statements just made are tabulated in the accompanying Key to the species described in the following pages.

Family **Comatulidae.**

I. Mouth central or subcentral: anus excentric 1).
  Ambulacra spotted with sacculi.
  Oral pinnules not provided with a terminal comb.
        Genus **Antedon**, de Frem.

  A. Ten arms.
    α. 60 overlapping cirrhus-joints . . 1. *perspinosa.*
    β. Less than 30 cirrhus-joints.
      I. Arm-joints compressed and keeled. . . . . 2. *carinata* Lam.
      II. Arm-joints rounded.
        1. Second radials closely united laterally.
          Second brachials have a strong backward projection into first brachials. 3. *pinniformis.*
        2. Second radials not united laterally.
          Second brachials without backward projection . . 4. *serripinna.*
  B. Rays may divide three or four times; each division of two joints, the axillary without a syzygy.
    α. Later cirrhus joints spiny.
      I. Rays in close contact; the lower joints of their outer arms flattened laterally . . 5. *flagellata.*
        Lower pinnules stout. Mus. Leyd.

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1) The generic differences between *Antedon* and *Actinometra* are given in more detail in my First Report on the *Comatulae* dredged by the U. S. Coast Survey. See the Bull. Mus. Comp. Zoöl. Vol. IX, n° 4. Cambridge, U. S. 1881.

ɪɪ. Rays well separated.
Lower pinnules slender . 6. *elongata.* Mus. Leyd.

β. Later cirrhus-joints not spiny.

ɪ. Pinnule on sixth brachial larger than that on fourth brachial . . . . 7. *bimaculata.*

ɪɪ. Pinnule on fourth brachial larger than that on sixth brachial.

1. Lower pinnules not specially stiff.
Smooth wedgeshaped arm joints with forward projections alternately on opposite sides.

a. Second radials much longer at sides than in the middle. Rays in close contact; outer joints of primary arms flattened laterally. . . . . 8. *brevicuneata.*

b. Second radials scarcely longer at sides than in the middle. Rays well separated . . . . 9. *laevicirra.*

2. Lower pinnules stiff and styliform.
Arm-joints bluntly wedgeshaped, without forward projections . . . . 10. *spicata.*

II. Mouth more or less excentric; anus subcentral.
No sacculi at sides of ambulacra.
Oral pinnules provided with terminal combs . . . . . . Genus **Actinometra** Müll.

A. Second and third radials united by syzygy.

- α. Ten arms . . . . 11. *solaris* Lam.
- β. Many arms. Rays may divide five times or more. First division of 3 joints, the axillary with a syzygy. Subsequent divisions of two joints united by syzygy.
  - I. Centrodorsal bears functional cirrhi . . . . . 12. *Novae Guineae.* Mus. Leyd.
  - II. Centrodorsal stellate, without functional cirrhi . . 13. *typica* Lovén.

B. Second and third radials united by ligament.

Many arms. First ray division of three joints, the axillary with a syzygy.

- α. Rays divide three times. Subsequent divisions like the first.
  - I. Lower pinnules large and massive . . . . 14. *robustipinna.*
  - II. Lower pinnules not specially stout.
    - 1. 50 cirrhi. First two radials concealed. Axillaries long with sharp distal angle . . . . . 15. *japonica.* Mus. Leyd.
    - 2. Not more than 25 cirrhi. 3 radials visible. Axillaries have wide angle . . . . 16. *parvicirra.* Müll.
- β. Rays may divide five times or more.
  - I. Third and fifth ray-divisions like the first. Second and fourth divisions of two joints, the axillary without a syzygy. . . . . 17. *alternans.*

II. All ray-divisions like the first.
  1. Rays in close contact: the joints flattened laterally as far as the third axillary . . . . . 18. *Schlegelii.*
  2. Rays more or less separated. Lower joints not flattened.
    a. 50 cirrhi of 25 unequal joints . . . 19. *Bennetti.* Mus. Leyd.
    b. 25 cirrhi of about 30 tolerably equal joints. 20. *Peronii.*

I. Antedon de Freminville. 1811.

1. ***Antedon perspinosa***, n. sp.

Description of an individual.

Centrodorsal discoidal, bearing upon its margin about 20 long and slender cirrhi. These are composed of about 60 joints, the lowest of which are slightly longer than broad. Each joint in the lower and middle parts of the cirrhus expands towards its distal end so as to overlap the base of the next joint, and its edges are fringed with small spines. This overlap gradually disappears on the ventral side of the later joints, and becomes gradually replaced on the dorsal side by two small spines near the middle of each joint. In the terminal joints these spines become smaller and closer together, and the penultimate one bears a single larger spine in opposition to the terminal claw.

The first radials are partially visible; the second twice their length, nearly oblong, and quite free laterally: the axillaries pentagonal with a wide distal angle and nearly twice the length of the second radials. The middle line of their apposed edges is marked by a slight spiny tubercle, and there is a similar but less marked one on the junction of the first and second brachials. Arms ten, of 150 + joints. First brachials rhomboidal, almost completely united laterally; the second longer and more wedgeshaped. These two joints and the axillaries have irregular blunt processes on their outer edges. The next four or five joints are transversely oblong. The following ones longer, sharply wedgeshaped, and overlapping. Towards the ends of the arms they become blunter and squarer. The raised distal edges of all the joints are fringed with short spines.

The first syzygium is on the third brachial, and the next is usually on the seventh or eighth brachial. After this the syzygial interval may be from three to eighteen joints, being usually three or four joints in the lower parts of the arms, and six or seven joints in their outer portions. The lower pinnules are stiff and styliform, consisting of about fifteen long, cylindrical, and overlapping joints with expanded and spiny distal edges. That on the fourth brachial is slightly longer than that on the second; and the following ones gradually diminish in stoutness and stiffness, but increase in length and in the number of joints. Those on the outer parts of the arms reach nearly twenty millim. in length and consist of about thirty elongated joints with expanded distal ends bearing numerous spines, the outermost of which are much longer than the rest.

Disc naked and much incised; 7 mm. in diameter.

Spread, about 30 centim.

Colour, dark reddish brown: sacculi moderately close along the pinnule ambulacra.

Locality. The Island of Jobie. Coll. von Rosenberg.

2. ***Antedon carinata***, Lam. sp.

1811. *Antedon gorgonia?* de Freminville. Nouv. Bull. d. Scienc. par la Soc. Philomat., II, p. 349.

1815. *Alecto carinata?* Leach. Zool. Miscell., II, p. 63.
1816. *Comatula carinata*, Lamarck. Syst. d'Anim. sans Vert. II, p. 536.
1834. *Comatula carinata*, de Blainville. Manuel d'Actinologie, p. 249.
1843. *Alecto carinata*, Müller. Wiegm. Archiv. 1843, I, p. 135.
1849. *Comatula* (*Alecto*) *carinata*, Müller. Abhandl. d. Berlin. Akad., p. 252.
1862. *Comatula carinata*, Dujardin. Hist. Nat. des Zoophytes. Echinodermes, p. 200.
1865? *Alecto Braziliensis*, Lütken. M.S.
1868. *Antedon Dübenii*, Verrill (non Bölsche). Trans. Conn. Acad. I, p. 365 (with?).
1878. *Antedon carinatus*, Pourtales. Bull. Mus. Comp. Zoöl. V, p. 214 (with?).
1879. *Antedon Brasiliensis*, P. H. Carpenter. Proc. Roy. Soc. N⁰. 194, p. 386.
1879. *Antedon carinata*, P. H. Carpenter. Trans. Linn. Soc., Sec. Ser. Zool., II, p. 29.
1879. *Antedon carinatus?* Rathbun. Trans. Conn. Acad. V, p. 156.
1881. *Antedon carinata*, P. H. Carpenter. Bull. Mus. Comp. Zool. Vol. IX. N⁰. 4.

The Museum contains a small and mutilated specimen of this widely distributed species from the Indian Ocean. It differs from specimens obtained at Mauritius (the original locality of the species) in the somewhat larger relative size of the lower pinnules, and in the greater smoothness of the outer portions of the arms.

3. ***Antedon pinniformis***, n. sp.

Description of an individual.

Centrodorsal a convex disc bearing about 12 marginal cirrhi. These have about 25 thick joints none of which are longer than broad. Each one from the eighth onwards bears a slight dorsal spine which becomes somewhat larger on the penultimate joint. The first radials are partially visible; the second oblong and almost completely united laterally. Axillaries widely pentagonal, nearly twice the length of the second radials, with strong backward projections into them, the surfaces of both joints rising somewhat towards their junction. Ten arms. First brachials bluntly wedgeshaped, and closely united laterally. Each has its distal border incised to receive a strong backward projection of the irregularly shaped second brachial. Third brachial oblong, a syzygy. The next five joints are wide and nearly oblong, with slight backward projections from their proximal edges alternately on opposite sides of the arm; the following joints longer and wedgeshaped, becoming more oblong again in the outer parts of the arms.

Syzygia very irregular after the first one on the third brachial; the next may be anywhere between 14 and 21; then an interval of 5—18 joints between successive syzygia.

The stoutest pinnules are those borne by the fourth and fifth brachials, which consist of about 12 thick joints slightly longer than broad. Those on the second and third brachials are less stout at the base but about as long as those on the sixth and seventh joints, the immediate successors of which are the shortest pinnules on the arm The following pinnules gradually increase in length, their component joints becoming longer but more slender. The outer pinnules are longer than the lower ones, and being very closely set give the arms a very feathery appearance.

Disc naked; 5 mm. in diameter. Spread about 12 centim.

Colour, white: the arms rather scantily clothed with a browner perisome, so that the ambulacra are close down on the muscles.

Sacculi closely set along the pinnule ambulacra.

Locality. Andai, New Guinea.

4. **Antedon serripinna**, n. sp.

Description of an individual.

Centrodorsal discoidal, bearing about 12 marginal cirrhi. These have about 18 thick joints none of which are longer than broad, the penultimate one bearing a blunt spine.

The first radials are scarcely visible even at the angles of the calyx; the second nearly oblong and not united laterally; the axillaries less than twice their length, almost triangular, with wide distal angles and slight backward projections from the middle of their bases.

Ten arms. First brachials almost rhomboidal, and closely united laterally; the second distinctly shorter and more wedgeshaped. Third brachial a syzygy, transversely oblong or nearly square. The next few joints short and oblong, and the following ones longer and sharply wedgeshaped, gradually becoming blunter towards the arm-ends.

The first syzygium is on the third brachial, and the next usually between 11 and 15; after which the syzygial interval is usually 3 or 4 joints.

The stoutest pinnules are those borne by the fourth and fifth brachials. They consist of about 15 joints, all but the uppermost of which are short, broad, and thick with their distal edges projecting beyond the base of the next joint, so as to give the pinnule a serrated outline. The pinnules on the second and fourth joints are slightly longer than those on the third and fifth joints respectively. Those immediately following are shorter and composed of a few elongated joints, after which the length gradually increases, though never much exceeding that of the large lower pinnules.

Disc, naked and somewhat incised; barely 5 mm. in diameter. Spread about 6 centim.

Colour, white with deep purple bands on the arms, especially at the syzygies. Sacculi closely set along the pinnule ambulacra, and rather farther apart on the arms.

Locality. Andai, New Guinea.

5. ***Antedon flagellata***, Mus. Leyd. sp.

1841. *Alecto flagellata*, Müller. Monatsbericht d. Berlin. Akad. p. 186. — Id., Wiegman's Archiv. 1841, I, p. 145.
1849. *Comatula flagellata*, Müller. Abhandl. d. Berlin. Akad. 1849, p. 263.
1862. *Comatula flagellata*, Dujardin. Hist. nat. des Zoophytes. Echinodermes, p. 206.

Description of an individual.

Centrodorsal moderately thick, with a smooth dorsal surface and three irregular rows of cirrhi on its sides. About 40 cirrhi, of 25-35 tolerably equal joints, hardly any of which (in mature cirrhi) are longer than wide. The lowest joints are short, the length increasing gradually up to the tenth joint which is about square. The next two or three joints are of the same shape or a trifle longer, after which the length gradually decreases and a blunt dorsal spine appears near the distal ends of the joints. It increases slightly in size for two or three joints, then diminishes and comes to be nearer their proximal ends, reappearing on the penultimate joint as a moderately strong opposing spine.

The first radials are scarcely visible even at the angles of the calyx; the second and third very convex, the former in close contact laterally; the latter less than twice their length, almost triangular, with very open angles.

38 arms, each of about 200 joints. The rays may divide four times, each division of two joints, the axillary not a syzygy, short and wide with an open angle. The first joints after each division closely united laterally, and slightly raised in the middle of their junction with their successors.

The first three or four brachials on the two outer arms of each ray have their outer sides flattened where they are opposed to their fellows of the next ray. First brachials rhomboidal; the second shorter and more wedgeshaped. The third a syzygy and more nearly oblong; the next five or six short and oblong, after which the joints become sharply wedgeshaped and somewhat longer, though still relatively short. After about the 50th joint they become blunter and more oblong, and finally somewhat squarer towards the arm-ends.

The first syzygium is on the third brachial, and the next usually between 15 and 21; then an interval of 9—16 joints between successive syzygia.

The largest pinnules are those borne on the fourth and five following brachials. Those on the sixth and seventh brachials are the longest on the arm and consist of 25—30 stout cylindrical joints. The first pair, on the second and third brachials, are considerably shorter and smaller than their three successors on each side; the pinnule on the tenth brachial is small on the inner arms of the ray, but more equal to its predecessor on the outer arms. The next few joints bear the smallest pinnules on the arm, after which the length gradually increases towards the arm-ends, but the pinnules never become specially long.

Disc, naked and much incised; 25 mm. in diameter.

Total spread about 25 centim.

Colour brownish white with greyer perisome. Sacculi not very abundant along the pinnule ambulacra.

Locality. Uncertain. Coll. Brugmans.

Remarks. The general *facies* of this fine species leaves little room for doubting its Oriental origin; but I have never come across a second specimen of it. The specific name as in the case of Müller's other types in the Leyden Museum (except *Actinometra solaris*), seems to have been a Museum name which was adopted by him.

Two *Myzostoma*-cysts occur on the arms of this specimen, which seem to have escaped Müller's attention.

6. ***Antedon elongata***, Mus. Leyd. sp.

1841. *Alecto elongata*, Müller. Monatsbericht d. Berlin. Akad. p. 187. — Id., Wiegman's Archiv. 1841, I, p. 146.

1849. *Comatula elongata*, Müller. Abhandl. d. Berlin. Akad. 1849, p. 257.

1862. *Comatula elongata*, Dujardin. Hist. nat. des Zoophytes. Echinodermes, p. 204.

Description of an individual.

Centrodorsal a moderately thick convex disc bearing about 30 cirrhi in two irregular rows round its margin. The cirrhi have 25—30 tolerably even sized joints, the sixth and four following ones of which are slightly longer than broad. The succeeding ones bear slight dorsal spines, that on the penultimate joint enlarging somewhat as an opposing spine to the terminal claw.

The first radials are just visible; the second, united laterally, short, wide, and very convex; the axillaries short, less than twice the length of the second radials, and pentagonal with wide distal angles. The rays are well separated and bear more than twenty (20 +) arms of over two hundred joints. They may divide three times, each division of two joints, the axillary not a syzygy. The first joints after each axillary are rhomboidal, closely united laterally, and form with their successors a slight tubercular elevation in the middle of their line of junction.

Second brachials bluntly wedgeshaped and slightly longer than preceding joints; the third (syzygies) and fourth, short and oblong. The next few joints have slightly oblique terminal faces, and the following ones are smooth, short, and sharply wedgeshaped, becoming shorter and blunter about the fortieth joint and squarer towards the ends of the long arms.

First syzygium on the third brachial; the next usually between 8 and 17; then an interval of 4—11, usually 6—8 joints between successive syzygia.

The first two pinnules are moderately short and slender, the size increasing up to those borne on the sixth, seventh, and eighth brachials. These have wide basal joints, the later ones being longer and tapering rather rapidly.

Pinnules on ninth and tenth brachials a good deal smaller than that on the eighth, but larger than the first pair.

The following ones gradually increase in length and slenderness, their component joints becoming more and more cylindrical, but they never exceed the length of the third pair. Terminal pinnules again shorter, very thin and delicate.

Disc lost. Spread about 25 centim. Diameter across the circle of palmar axillaries about 14 mm.

Colour, brownish white with darker perisome. Sacculi numerous at sides of pinnule ambulacra.

Locality. New Guinea. Coll. S. Müller.

Remarks. This is another of Müller's types for which he employed a Museum-name. I have not seen any duplicate of it.

7. ***Antedon bimaculata***, n. sp.

Description of an individual.

Centrodorsal a thick spreading disc, with a slightly hollowed dorsal surface, and bearing about 40 marginal cirrhi. These have about 25 joints, of which the fifth and three following ones are slightly the longest. The following joints diminish slowly in size and the penultimate has a blunt opposing spine to the terminal claw.

The first radials are just visible at the angles of the calyx; the second short, and in close contact laterally; the axillaries more than twice their length, widely pentagonal with open distal angles.

More than thirty-six (36+) arms of 150 joints. The rays may divide three times, each division of two joints which are slightly raised in the middle of their junction, the axillary not a syzygy. The first joints after each axillary are rhomboidal and closely united laterally. Second brachials shorter than the first and more wedgeshaped; the third (syzygies) and five or six following joints more oblong. The next joints are short and sharply wedgeshaped, becoming blunter again about the 40th joint, more oblong, and squarer or slightly elongated towards the arm-ends.

First syzygium on the third brachial; the next between 18 and 23; then an interval of 6—18, usually 7—11 joints between successive syzygia. Lower pinnules stiff. The first pair small; the next pair nearly twice their length, and the following ones, on the sixth and seventh brachials respectively, are the longest on the arm, consisting of about 30 stout cylindrical joints.

Pinnule on the eighth brachial nearly as long as that on the sixth, but the next pair are much smaller, after which the size increases very gradually till near the arm-ends; but the outer pinnules though slender never become specially long.

The pinnules on the fifth and seventh brachials are nearly equal on some of the smaller arms and the relative sizes of all the lower pinnules are apt to vary a good deal upon arms which have been restored from the first or second brachials.

Disc, naked and much incised; 17 mm. in diameter.

Spread, about 20 centim.

Colour. Skeleton grey up to the last axillary. Arm-bases grey or white, and marked with a double row of purplish spots. The first of these is near the outer end of the line between the second and third brachials; the next towards the inner end of the line separating the third and fourth joints, and so on alternately on opposite sides for four or five joints. Beyond this limit the arms are dark purple, or almost black, with occasional white patches. Sacculi numerous along the pinnule ambulacra.

Locality. Amboyna.

The peculiar colouring and the large size of the third pair of pinnules readily distinguish this species among the few *Antedons* hitherto recorded from the Moluccas.

8. ***Antedon brevicuneata***, n. sp.

Description of an individual.

Centrodorsal a thick disc with a slightly hollowed dorsal surface, and a single or partially double row of marginal cirrhi. There are about 30 of these consisting of 25—30 tolerably equal joints, the 6th and 7th about square and the next two or three just longer than broad. The following joints diminish gradually in size towards the end, but without developing dorsal spines except for a small and blunt one on the penultimate.

First radials not visible; second and third very convex, the former being shorter in the middle than at the sides where they are closely united to their fellows; axillaries short, pentagonal, with wide distal angles, less than twice the length of the second.

39 arms. Rays in close contact but dividing three times, each division of two joints, the axillary not a syzygy. The joints of the primary arms on the outer sides of the rays are somewhat flattened laterally where they are in contact with their fellows. First brachials large and rhomboidal; the second shorter, and much more wedgeshaped: the third (syzygy) nearly square, rather longer on inner than on outer side. The next five joints nearly oblong with slight forward projections alternately from the outer and inner sides of their distal edges. The following joints are smooth, short and wedgeshaped, retaining the forward projection about as far as the 60th, but much more markedly in some arms than in others. Later joints gradually become blunter and nearly square at the extreme arm-ends. First syzygium on 3rd brachial; the next on 4, 5, 9, or as far as 17; then an interval of 7—18 joints, usually about 10, between successive syzygia.

The largest and stoutest pinnule on the outer side of the arm is the second, borne by the 4th brachial. It is about 10 mm. long and consists of about 25 joints which are stout at the base but taper away rapidly towards the end. 5th brachial bears a similar but somewhat smaller pinnule. Relative sizes of pinnules on 2nd and 6th br. rather variable, but both are smaller than that on 4th br. Fourth pinnule (on 8th br.) of only 7 or 8 small joints, a good deal shorter than the third, and only about one quarter as long as the second pinnule. Following pinnules gradually increase in length and size, and the joints of the later ones become more elongated; but they never reach the length of the large basal pinnules, nor are they very closely set.

Disc, naked and deeply incised, almost to the centre; diameter 10 mm.

Spread, 18 centim.

Colour, calyx and arm-bases white with darker patches; lower arms a dirty brownish grey, and their outer portions the same mottled with white. Sacculi not very close on pinnule ambulacra.

Locality, Amboyna.

9. ***Antedon laevicirra***, n. sp.

Description of an individual.

Centrodorsal discoidal with a flat cirrhus-free dorsal surface, and bearing about 30 cirrhi in a single or partially double marginal row. Cirrhi of 25—30 tolerably uniform smooth joints, few or none of which are longer than broad; penultimate has a faint opposing spine to the small terminal claw.

First radials not visible; the second short and nearly united laterally; axillaries more than twice their length, pentagonal with wide distal angles.

Nearly 40 arms of about 160 smooth joints. Rays divide three times; each division of two joints, the first closely united to their fellows, and the axillary not a syzygy. First brachials almost rhomboidal, relatively long and narrow, closely united to their fellows. Second joints much shorter and nearly oblong; third (syzygy) nearly square. The next six joints short and nearly oblong; the following ones longer and sharply wedgeshaped with traces of a forward projection alternately on opposite sides, as in the last species. Outer joints becoming blunter, squarer and slightly elongated towards arm-ends.

First syzygium on 3rd brachial; the next between 18 and 21; then an interval of 9—13 joints, usually 11, between successive syzygia.

The longest and stoutest pinnules on the arm-bases are those borne by the 4th and 5th brachials, the former consisting of about 25 tapering joints being considerably the larger. Third pair (on 6 and 7 br.) smaller than the first pair, and the fourth pair still more so, being the smallest pinnules on the arm. The length of the following pinnules gradually increases but never reaches that of the second pair, and their component joints are not specially delicate, while they are well clothed with perisome up to the arm-ends where the size again decreases.

Disc naked, and somewhat incised; 12 mm. in diameter.

Spread, 25 centim.

Colour, blackish with lighter bands.

Locality. Aru-Islands. Coll. von Rosenberg.

10. ***Antedon spicata***, n. sp.

Description of an individual.

Centrodorsal thice, discoidal, with a small, slightly hollowed dorsal surface, and very sloping sides which bear about 25 cirrhi in an irregular double row. These have about 25 joints, the fourth of which is longer than wide; the next three are the longest and the following ones diminish gradually in length, the penultimate having a tolerably strong opposing spine.

First radials barely visible; the second oblong and not united laterally; axillaries pentagonal with wide distal angles and relatively short, only half as long again as the preceding joints. The outer edges of the axillaries and of the next three or four joints bear small irregular tubercles. 28 arms of nearly 200 joints. Rays divide three times; each division of two joints, the first almost completely united to their fellows, and the axillary not a syzygy. First brachials widely rhomboidal; the second of about the same length but more wedgeshaped; the third (syzygy) nearly square. The next four are oblong, and the following ones wedgeshaped, of medium length, and very slightly overlapping; the later ones are blunter and more oblong, becoming squarer and slightly elongated at the arm-ends.

The muscle-plates of successive joints stand up rather prominently, alternately on either side of the ambulacral groove.

First syzygium on 3rd brachial; the next between 15 and 18; then an interval of 3—10 joints, usually 5—7, between successive syzygia.

The second brachial bears a moderately long but slender pinnule, and the next joint a shorter one; the next pair on 4th and 5th joints are longer than the first pinnule, stiff, tapering, and styliform, consisting of about 15 elongated joints. That on the 4th joint is the longer, reaching 15 mm.

The next pinnule is stiff but shorter again, and the following ones decrease till about the tenth brachial, after which the size increases slowly. Towards the arm-ends the pinnules become slender and filiform, but they never reach the length of the second pair.

Disc naked and much incised; 17 mm. in diameter.

Spread, 20 centim.

Colour, the skeleton light purplish red with darker bands at the junctions; the perisome very much darker, almost black. Sacculi closely set along the pinnule ambulacra.

Locality. The Banda Sea. Coll Dr. Semmelink.

Remarks. This type differs from *Ant. articulata*, the Moluccan species described by Müller, in having fewer cirrhus joints and no spines on the later ones. The syzygial interval on the arms is much shorter, and the fourth pinnule is relatively smaller.

Antedon seems to be comparatively rare in the Moluccas. I know of more than a dozen *Actinometra*-species from these islands, but of only six *Antedons* which with one ten-armed exception (*Ant. Jacquinoti* Müll. sp.) all agree in the characters of the ray-divisions. Three of them have been described above; two are at Paris, and the remaining one in the University Museum at Berlin, having been brought from Batjan by Prof. E. von Martens.

Ant. spicata is closely allied to the Fijian *Ant. protecta* Lütken M.S. which has nearly 50 cirrhi, smoother arm-joints, and a relatively smaller pinnule on the fifth brachial; but the stiff and pointed lower pinnules are striking features of both species.

II. **Actinometra.** Müller, 1841; emend. P. H. Carpenter. 1877 [1]).

11. ***Actinometra solaris***, Lam. sp.

1816. *Comatula solaris*, Lamarck. Syst. d'Anim. sans Vert. II. p. 534.
1834. *Comatula solaris*, de Blainville. Manuel d'Actinologie. p. 249.
1841. *Actinometra imperialis*, Müller. Monatsber. d. Berlin. Akad. 1841. p. 181.
Wiegman's Archiv. 1841. I. p. 141.
1843. *Alecto solaris*, Müller. Wiegman's Archiv. I. p. 135.
1849. *Comatula* (*Actinometra*) *solaris*, Müller. Abhandl. d. Berlin. Akad. 1849. p. 248.
1862. *Comatula solaris*, Dujardin. Hist. nat. des Zoophytes. Echinodermes. p. 200.
1862. *Actinometra imperialis*, ibid. p. 209.
1869 *Comatula* (*Actinometra?*) *hamata*, Kuhl and v. Hasselt. Herklots J. A. Echinodermes peintes d'après nature par les soins de Kuhl, van Hasselt, et Sal. Müller. Amsterdam. Bijdragen tot de Dierkunde. IX p. 10. Pl. IX.
1879. *Actinometra solaris*, P. H. Carpenter. Trans. Linn. Soc., Sec. Ser. Zool. Vol. II. p. 27.

The single specimen of this species in the Museum ap-

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1) Journ. Linn. Soc. Zool. Vol. XIII. p. 441.
See also, Trans. Linn. Soc., Sec. Ser. Zool. Vol. II p.p. 18—20.

pears to be the one brought from Cape Bantano by Salomon Müller, and figured in the »Echinodermes peintes d'après nature" as *Comatula* (*Actinometra?*) *hamata*. Kuhl and van Hasselt. The type is a very variable one, however, and this specimen does not appear to be sufficiently distinct from Lamarck's original specimen in the Paris Museum to justify the establishment of an other species.

12. **Actinometra Novae Guineae**, Mus. Leyd. sp.

1841. *Alecto Novae Guineae*, Müller. Monatsber. d. Berlin. Akad. 1841. p. 186. Wiegm. Archiv. 1841. I. p. 146.
1849. *Comatula Novae Guineae*, Müller. Abhandl. d. Berlin. Akad. 1849. p. 264.
1862. *Comatula Novae Guineae*, Dujardin. Hist. Nat. des Zoophytes. Echinodermes. p. 208.

Description of an individual.

Centrodorsal a thin pentagonal disc, with its angles slightly produced and about 15 cirrhus-sockets on its sloping sides. Cirrhi all lost. Traces of clefts appear between the sides of the centrodorsal and the inner margins of the short first radials. Second radials shorter than the first, widely hexagonal, and only partly united laterally.

Axillaries free, pentagonal, barely two and a half times the length of the second, to which they are united by syzygy. Rays quite free laterally, dividing four or five times. Primary arms of three distichal joints, the axillary a syzygial or double joint. In subsequent divisions every second joint is an axillary united by syzygy to its predecessor, which is only partly united laterally with its fellow. 56 arms First brachial a syzygy, oblong or nearly square; the second usually simple, but sometimes a syzygy. The next two or three joints are transversely oblong, and their immediate successors longer, wedgeshaped, and slightly overlapping. After this both length and breadth diminish and the joints gradually become blunter and smoother, elongating again towards the arm-ends. The arms are dimorphic, those on one side of the calyx (probably posterior) being shorter, with only 60—70 joints, and tapering more rapidly than the longer anterior arms with 80—90 joints.

First brachial a syzygy, and frequently also the second, especially on those single undivided arms borne by axillaries which bear dividing arms on their other faces. The next syzygy usually on the 8th or 9th joint, after which an interval of two joints, or sometimes only of ones between, successive syzygia.

The second distichal bears a moderately long pinnule with a well marked terminal comb. The next pinnule (normally) is on the epizygal of the first brachial. Its size and that of the pinnule on the second brachial vary considerably, being greater on the outer than on the inner arms of each ray; but there is a gradual decrease from the first pinnule to those on the fourth and fifth brachials after which they increase again, losing the terminal comb about the 8th brachial. Their cuboidal joints have spiny tufts in the mediodorsal line, and at the distal end of each joint are one or two rather larger lateral spines. Towards the arm-ends the pinnules gradually become more slender, but increase very little in length, their joints becoming oblong and the large lateral spines almost entirely limited to their outer sides.

Disc lost; some of the shorter arms have only an imperfect groove and tentacular apparatus, or none at all.

Colour, skeleton greyish white; the perisome a darker grey.

Spread, about 180 centim. Diameter of calyx measured across the radials, 10,5 mm.

Locality, The Island of Eidouma, New Guinea.

Coll. Sal. Müller.

Remarks. The above description differs considerably from that which was drawn up by Müller on the basis of Troschel's examination of this specimen. He is not very clear as to whether there are three or four joints in the primary arms; but he says distinctly that no axillary has a syzygy. As a matter of fact there are three distichal joints of the usual character, the third or axillary being a syzygial or double joint; and though the successive axillaries are separated only by single joints, yet these very joints are united by syzygies to the axillaries above them. Further, the second and third radials are united by syzygy, and the first brachial is also a syzygial or double joint, as to both of which characters Müller is silent.

Misled by Müller's description I have mentioned *Com. Novae-Guineae* as among the *Comatulae* dredged by the »Challenger" [1]). This, however, is not the case, though the type in question (from Banda) corresponds very closely with Müller's specific diagnosis of the New Guinea specimen. Even as it is I cannot be positively sure that there are syzygies in this last between the two outer radials, and between each axillary and the joint below it, as it presents no natural fractures; and future dissection of another specimen may show that this is not the case. Under these circumstances the specific diagnosis of the type would require a second revision; but I venture to think that this will not be necessary.

The nearest ally of *Actinometra Novae Guineae* is the singular type described by Lovén under the name of *Phanogenia* to which we will now pass on.

13. ***Actinometra typica***, Lovén. sp.

1866. *Phanogenia typica*, Lovén. Ofvers. af. K. Vet. Akad. Förh. Arg. 23. N°. 9. p. 231.
Actinometra stellata, Lütken. M.S. Museum Godeffroy.

Locality, Jobie. Coll. von Rosenberg.

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1) Proc. Roy. Soc. 1879. N°. 194, p. 386.

The genus *Phanogenia* was established by Lovén in 1866 for the reception of some remarkable *Comatulae* from Singapore¹). They are especially characterised by having a more or less stellate centrodorsal which bears few or no traces of cirrhus-sockets, and occupies but does not completely fill the central space within the radial pentagon. The same peculiarity was noted by Dr. Lütken in an *Actinometra* of the Godeffroy collection from Fiji, to which he gave the M.S. name *Actinometra stellata*; and duplicates of the type have been distributed from the Godeffroy Museum under this name. Having examined some of these duplicates and also, by the kindness of Prof. Lovén, his original specimens of *Phanogenia* I am disposed to regard the two types as identical. During my visit to Copenhagen last autumn I was glad to learn that the same idea had also occurred to Dr. Lütken, with whom I am pleased to find myself in accordance as to the generic position of the type.

In my preliminary report²) upon the *Comatulae* of the »Challenger" Expedition I pointed out that the peculiar stellate condition of the centrodorsal of *Phanogenia* »appears to be one of the concluding stages of a long series of changes in the shape and relations of the centrodorsal, which do not commence until some time after the loss of the stem, and the entry upon the free state of existence." I also gave some account of these stages as exhibited by *Actinometra jukesii* and by other species of the genus³). But not having seen *Phanogenia* at that time I felt unable to refer it to *Actinometra* in the face of Lovén's description, »*Os centrale ..... sulci tentaculiferi fere quales in Antedone.*" Since my examination of it, however, I do not

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1) Phanogenia, ett hittills okändt slägte af fria Crinoideer. Öfvers. af K. Vet. Akad. Förh. Arg. 23. N°. 9. pp. 223—233.

2) Proc R. S. 1879. N°. 194. pp. 390—392.

3) It is worth notice that a fossil *Actinometra* with a stellate centrodorsal devoid of cirrhus-sockets has been found in the Gault (*Albien*) of Folkestone. Quart. Journ. Geol. Soc. Vol. XXXVI. p. 51.

think that it can be regarded as generically distinct from *Actinometra*; though there are certain features about it, besides the stellate centrodorsal, which distinguish it in a very marked manner from the other species of the genus.

In ordinary *Actinometra*-species [1]) the mouth is some little way from the centre of the disc which is occupied by the anal tube. But in Lovén's specimens from Singapore, as in Lütken's from Fiji and in others which I shall mention immediately, the mouth, though not absolutely central, is only slightly excentric, and the anus is at or near the margin of the disc. In fact it is sometimes very difficult to find the anus at all. In this respect the disc of *Actinometra typica* approaches that of *Antedon*; but the distribution of the ambulacra is not so symmetrical as in *Antedon*, and the anal interradius is always by far the largest. The presence of a terminal comb on the oral pinnules, the general features of the calyx, and the absence of sacculi from the pinnule ambulacra also distinguish this type very sharply from *Antedon*.

Another character in which *Act. typica* differs from ordinary *Actinometra*-species and also from *Antedon*, is in the peculiar mode of union of the second and third radials which I believe to be an imperfect form of syzygy, although Lovén [2]) describes it as a ligamentous articulation.

When two joints are united by syzygy, as the two outer radials are in *Act. jukesii*, *Act. solaris*, *Act. robusta* and others, each of their apposed faces is marked by a number of low ridges, which diverge from the opening of the central canal and extend towards the dorsal margin of each joint, causing it to be delicately toothed [3]). In the natural positions of the apposed faces their ridges correspond in position, so that the presence of the syzygy is indicat-

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1) Trans. Linn. Soc. Ser. 2. Zool. Vol. II. Pl. 1. Pl. 2. figs 1, 8.

2) Loc. cit. p. 228.

3) This is well shown in fig. 7 D on Pl. XXXVI of Dr. Carpenter's memoir on *Antedon rosacea*. Phil. Trans. 1866.

ed' by a delicate dotted line which crosses the dorsal surface of the compound joint, the dots indicating the gaps between adjacent pairs of corresponding ridges [1]).

In a true ligamentous articulation, on the other hand, such as occurs between the outer radials of every *Antedon* [2]) and of most *Actinometrae* [3]) each of the articular faces is divided by a vertical ridge into two fossae which give attachment to the large interarticular ligaments. Each of these fossae is marked more or less distinctly by a series of concentric lines like the lines of growth in a bivalve shell; and the vertical articular ridge that separates them usually stands up rather prominently, especially around the opening of the central canal.

In *Actinometra typica*, however, these features are not visible on the apposed faces of the two outer radials [4]), which are almost flat and cannot be said to have any distinct articular ridge; and although there is a median vertical line on each face which divides it into two lateral halves, yet these are not fossae and show no traces of any concentric markings. Each of them is marked by a number of little elevations, squarish or oblong in shape, and so arranged as to have their longer axes radiating outwards from the central canal. This is much more marked in some cases than in others, and the result is that the joint-face looks as if the radiating ridges of a syzygy were interrupted at intervals. They do not, however, reach the dorsal margin, or only very rarely, so that the dotted line indicating a syzygy is hardly traceable.

In an ordinary *Antedon*-syzygy there is no division of the joint-face into two lateral portions as in the case just described which is thus somewhat intermediate in its nature, presenting a distinct approach to a ligamentous articulation while still retaining its syzygial character. Lovén has given a diagram of it as an articular face in *Phanogenia* (*Act. typica*), and I have studied it in a much mutilated specimen dredged by the »Challenger" in the neighbourhood of the Fiji Islands. The only reason for calling it an articulation is the presence of the median vertical line, which can hardly be called a ridge, dividing the face into two parts. But Lovén figures a similar ridge on the »facies syzygii brachialis 1—2 rami tertii" which is an undoubted syzygy [1]) with radiating striae reaching the dorsal margin. I find traces of a similar median line on the syzygial faces of the lower arm-divisions of the »Challenger" specimen, but it gradually disappears and the syzygial faces of the outer arm-joints are of the ordinary character.

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[1] Phil. Trans. loc. cit. Pl. XXXVI. figs. 5 D, 6 D.

[2] *Ibid.* figs. 2 B, 3 A, 4 B, 5 A.

[3] Linn. Trans. loc. cit. Pl. 7. figs. 2 b, 3 a, 5 b, 6 a.

[4] K. Vet. Akad. Förh. loc. cit. p. 230. fig. c. (Compare also figs. d, k, l.)

It may be noted here that radiating striae are not necessarily characteristic of a syzygy, being absent in *Pentacrinus* and in *Rhizocrinus*, in which the apposed faces are smooth and devoid of any markings whatever.

The following are the characters which I believe to be more especially distinctive of *Actinometra typica.* Lovén has already given an admirable detailed description of the type [2]).

»Centrodorsal stellate, with few or no cirrhus-sockets, and nearly flush with the radials. Second and third radials united by syzygy, but the junction line is rarely dotted. Rays may divide 7 or 8 times. Primary arms of three distichal joints, the axillary a syzygy [3]). Subsequent divisions each of two joints united by syzygy. A syzygy in the first brachials; the next usually between the 8th and 10th brachials, and then an interval of two joints between succes-

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1) Loc. cit. p. 230. d.

2) Loc. cit. pp. 231—233.

3) According to the usual rule, one would expect the first and second distichals (both in this and in the preceding species) to be united by syzygy like the outer radials. Not having seen a joint face I cannot speak positively, but judging from Lovén's description (p. 233) I think that there may possibly be a ligamentous articulation in this position.

sive syzygia. Pinnules decrease in length to about the 6th brachial and then increase again, but rarely, if ever, reaching the length of the lowest pinnules. Joints of middle and later pinnules very spiny. Mouth usually subcentral and radial, but the ambulacra unequal. Anus marginal."

No two specimens of this type that I have seen are precisely similar, but they pass into one another so very gradually that it is practically impossible to separate them. Von Rosenberg's specimen from Jobie is an exceedingly fine one with a disc measuring 20 mm. in diameter, and a spread of 25 centim. It is remarkable for the great length of its lowest pinnules, the first one reaching 16 mm., and also for the great development of spines on the elongated joints of the middle and later pinnules. Their edges are fringed with strong spines, and a still larger one projects forwards and upwards on each side near the distal end of each joint. Lovén's specimens from Singapore present the same features though to a less extent. They also have a deeper funnel in the centre of the radial pentagon and the centrodorsal sunk in it to nearer the level of the radials. The lower brachials are also more wedge-shaped, and their margins are elevated alternately on opposite sides.

Some large specimens from Cebu in the Philippines which are preserved in the Zoological Museums at Dresden and Vienna also belong to this species. They do not differ much from the type except that the lower pinnules decrease more gradually in size. In the »Challenger" specimen dredged near Fiji the arms are shorter and less fleshy, with less spiny joints, the terminal faces of which are less closely applied than in the type. The basal pinnules are relatively shorter and their joints less spiny; while those of the terminal pinnules are almost smooth and the pinnules stiffer, so that the arms have a less feathery appearance.

A Fiji specimen on the other hand, obtained from the Godeffroy Museum has moderately feathery arms and more spiny pinnules. As in the »Challenger" specimen and in von Rosenberg's large one from Jobie four of the primary arms consist of but two distichal joints which are united by syzygy as in the later arm-divisions; and it is quite possible that specimens may eventually be met with which have more than half the primary arms in this condition. Variations of a similar character are common in other *Actinometrae* and notably in *Act. parvicirra* but the arm-divisions of *Antedon* are generally much more regular.

Act. typica is the nearest ally of *Act. Novae Guineae*, but the metamorphosis of the centrodorsal is carried much further than in that type, it being markedly stellate in shape and bearing few or no cirrhus-sockets. In *Act. Novae Guineae*, on the other hand the centrodorsal bears some 15 functional cirrhus-sockets and presents but little departure from the ordinary shape. The joints of the terminal pinnules in *Act. typica* also are much longer and more slender than those of *Act. Novae Guineae*, which are comparatively stout and but little longer than broad. They are also peculiar in having the large lateral spines almost entirely limited to the outer side of each joint, instead of occurring on both sides as in *Act. typica.*

14. ***Actinometra robustipinna***, n. sp.

Description of a much mutilated individual.

Centrodorsal a thick disc slightly flattened at the dorsal pole, and bearing about 40 cirrhus-sockets in two marginal rows. First radials partially visible all round the calyx, but slightly diverging at each angle so as to leave a gap. This is bridged over by the proximal portions of the short second radials having lateral extensions which meet those of their fellows on either side. Axillaries pentagonal, quite free laterally, and rather more than twice the length of the second radials, with moderately sharp distal angles. Rays may divide three times; 17 + arms. Six of the primary arms consist of three distichal joints, the axillary a syzygy; and in three others there are only two joints, the axillary not a syzygy, the remaining one being broken away. The secondary arms (when present) consist of three palmar joints, the axillary a syzygy. The first pair of joints beyond each axillary are closely united laterally.

The pinnules borne by the second joints after each axillary are enormously large and stout; so much so, that the joints bearing them have almost the appearance of being axillaries themselves. Each pinnule contains 20 + massive joints, the ventral edges of which are produced so as to stand up as plates sloping slightly inwards towards the ambulacral groove. Disc lost.

Colour, light brownish white. Diameter of centrodorsal, 7 m.m.; total diameter between palmar axillaries, 25 mm.

Locality. The Moluccas. Coll. Macklot.

Remarks. Although no traces remain either of the disc or of a terminal comb on the oral pinnules, the flattened calyx and the wide funnel in the centre of the radial pentagon indicate the generic position of this specimen which is markedly different from most species of *Actinometra* that I have seen.

15. ***Actinometra japonica***, Mus. Leyd. sp.

1841. *Alecto japonica*, Müller. Monatsber. d. Berlin. Akad. 1841. p. 186. Wiegm. Archiv. 1841. p. 145.
1849. *Comatula japonica*, Müller. Abhandl. d. Berlin. Akad. 1849. p. 260.
1862. *Comatula japonica*, Dujardin. Hist. Nat. des Zoophytes. Echinodermes, p. 205.

Description of an individual.

Centrodorsal wide, discoidal, slightly hollowed in the centre, and concealing the greater part of the radials. About 50 cirrhi of some 20 joints, of which the third is longer than wide and the fifth the longest. The following ones decrease slowly in length, the terminal ones being deep and much compressed, with small and blunt dorsal spines, that on the penultimate joint not being specially large. Axillaries long with sharp distal angles.

27 + arms; the rays dividing three times. Primary and secondary arms each of three joints, the axillary a syzygy. First joints beyond each axillary only partly united laterally. First and second brachials both bluntly wedgeshaped, the first being the shorter and the more oblong. The next three joints short and nearly oblong; the following ones both longer and wider, wedgeshaped, and overlapping. After about the 15th joint the width decreases and the joints become more oblong, though still overlapping.

First syzygium on 3rd brachial; the next between the 10th and 14th joint; then an interval of 2—4 joints between successive syzygia.

All the lower pinnules are long, expecially the first ones on the second distichals which reach about 20 mm. in length. The following ones diminish gradually in length, that on the 6th brachial being a good deal shorter than its predecessor (on 4th br.) though still large. After this the pinnules are stouter and tolerably uniform in length, eventually becoming longer and more slender.

The large lower pinnules have sharp keels on the 6 or 7 basal joints. After the fifth or sixth brachial this carination is confined to the first four joints, dying away altogether after about the 20th arm-joint. The lowest pinnules, as far as the fifth brachials, have terminal combs. Mouth interradial. Disc naked, 25 mm. in diameter.

Spread probably between 15 and 20 centimetres.

Colour light brown, the perisome being darker.

Locality, Japan. Coll. von Siebold.

Remarks. This is a very well defined species, the axillaries being longer and having sharper distal angles than those of any *Actinometra* I have seen. The great length of the lower pinnules is also remarkable.

On this specimen, which is one of the types examined for Müller by Troschel I found over a dozen *Myzo-*

stomidae. They have been sent to my friend Prof. L. Graff of Aschaffenburg for determination and description.

16. ***Actinometra parvicirra***, Müll. sp.

1841. *Alecto parvicirra*. Müll. Monatsber. d. Berlin. Akad. 1841. p. 185 and Wiegman's Archiv. 1841. I. p. 145.
1841. *Alecto timorensis*. Müll. Monatsber. d. Berlin. Akad. 1841. p. 186. Wiegman's Archiv. 1841. I. p. 145.
1849. *Comatula* (*Alecto*) *parvicirra*. Müll. Abhandl. d. Berlin. Akad. 1849. p. 260.
1849. *Comatula timorensis*. Müll. Ibid. p. 263.
1862. *Comatula parvicirra*. Dujardin. Hist. Nat. des Zoophytes. Echinodermes. p. 206.
1862. *Comatula timorensis*. Dujardin. Ibid. p. 206.
1876. *Actinometra* (*Comatula*) *armata*. P. H. Carpenter. Journ. Anat. and Physiol. X. p. 582.
1876. *Actinometra armata*. P. H. Carpenter. Journ. Anat. and Physiol. XI. p. 91.
1877. *Actinometra polymorpha*. P. H. Carpenter. Journ. Linn. Soc. Zool. XIII. p. 439.
1879. *Actinometra polymorpha*. P. H. Carpenter. Trans. Linn. Soc., Sec. Ser. Zool. II. p. 51.
1881. *Actinometra polymorpha*. P. H. Carpenter. Quart. Journ. Micr. Sci. N. S. XXI. p. 185.

After much consideration I have been led to regard Müller's original specimens of *Comatula timorensis* Mus. Leyd. as identical with those described by him under the specific name *parvicirra*.

The two descriptions are on the same page in Vol. I of Wiegman's Archiv for 1841, while in the Berlin. Monatsberichte for the same year *Alecto parvicirra* is described on p. 185, and *Alecto timorensis* on p. 186. Müller says but little about his type specimens of *parvicirra* except that they are in the Paris Museum and that their locality is not known, his specific diagnosis being very meagre in its character. A specimen in the same Museum which had been obtained by Hombron and Jacquinot at Vavao (Friendly Islands) during the voyage of the Astrolabe was regarded by Müller as probably belonging to the same species (*C. parvicirra*). This specimen I found in the Museum under the name *C. brevicirra*, Troschel; while three small specimens from the voyage of Peron and Lesueur, bearing the Museum name of *C. simplex* may possibly be the originals of *C. parvicirra*. The chief difficulty in the way of this identification is the fact that in none of them do the rays divide more than twice, the number of arms being less than twenty; while Müller speaks of twenty-seven arms, the rays sometimes dividing three times. But whether they be his original specimens or not, they are identical with the one from Vavao which he placed under *C. parvicirra* and also with his type specimens of *C. timorensis*. I prefer to retain the former name to designate the species, not because *Alecto parvicirra* appears on p. 185, and *Alecto timorensis* on p. 186 of the Berlin. Monatsberichte for 1841, but because the former really expresses a distinctive characteristic of the type, and has the advantage of not connecting it with any definite locality.

The use of geographical terms as specific titles is often very tempting, but sooner or later the species is found at other localities than the one first recorded, and then the name becomes somewhat misleading. In the case of this species therefore which, for a *Comatula*, has a wide range, the name *parvicirra* has so much more in its favour than *timorensis* has that I prefer to use it, despite the slight uncertainty about the specimens for which it was originally employed by Müller.

The closer examination of the Paris specimens which I made during my second visit to the Museum last autumn, aided by the knowledge gained during four years of pretty continuous study of the *Comatulae*, has also led me to identify *C. parvicirra* with the series of specimens from the Philippine Islands which I have described under the name of *Actinometra polymorpha* [1]. Both in the Vavao specimen and in the small ones obtained by Peron and Lesueur the arm joints overlap much more strongly than they do in the Philippine examples, the distal edges of the successive joints being much more raised. This is also the case with the original specimens of *C. timorensis* in the Leyden Museum. Müller's description of them gives no information either about the position of the mouth, or about the presence of a terminal comb on the oral pinnules, and is therefore of no use for determining their generic position; and there are other species to which the description that he does give is almost as applicable as to *C. timorensis*.

The chief point of difference between the three Timor specimens and those from the Philippines is that in some of the former the overlap of the arm-joints is much more marked. In one individual indeed it almost ceases to be an overlap and shows the first trace of a carination. The dorsal surface of each joint, instead of sloping gradually upwards and outwards, rises very suddenly towards its distal edge which stands up sharply above the proximal edge of the next joint.

The distichal and palmar pinnules of the Timor specimens are more equal than in the Phillippine ones and their terminal comb is smaller, while the outer pinnules of the ungrooved arms are smaller and less fleshy, and bear none of the problematical »sense organs?" which are present in the corresponding pinnules of some of the Philippine individuals.

On the other hand the examples from the two localities agree, not only in their general external appearance, but also in their internal characters. Sections which I have made through one or two pinnules of the Timor specimens have shown that there is a pigmented cellular cord beneath the watervessel, and lateral trunks connecting the subtentacular and coeliac canals just as in the Philippine examples[1]), while the histological features of the ovary are identical in both. The Timor specimens also have several arms which are ungrooved either for the whole or for the greater part of their length. The proportions of ungrooved arms in the three individuals are respectively $\frac{8}{40}$, $\frac{10}{36}$ and $\frac{15}{38}$. The grooved anterior arms taper slowly, having 120 + joints, while in the short hinder arms there are only about 70 joints the last half of which lose the wedgeshaped appearance presented by the lower joints and become rapidly blunter and squarer; but they never become elongated like the terminal joints of the anterior arms.

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[1] Trans. Linn. Soc., Ser. 2. Zool. II. pp. 51—53. I have not thought it necessary to reproduce my diagnosis in these Notes, but confine myself to simply stating the general points of resemblance and difference between the Philippine and Timor specimens respectively.

Another specimen referable to this species is one from Bennett's collection, from some unknown locality in the East Indies. The overlap of the arm-joints is nearly as marked as in the Timor examples, but the spines on the outer cirrhus-joints are less developed and fewer of the lower pinnules have a terminal comb. This individual is remarkable for having dimorphic arms which are all grooved. The posterior arms taper much more rapidly than the anterior ones and are composed of fewer joints, but their ambulacra are nearly as well developed.

Two other examples of the same type were obtained at the Island Solor by Dr. Semmelink. They both agree in the relatively small size of the pinnule on the fourth brachial, and in having the terminal comb on the lowest pinnules larger than in the Timor specimens though the number of pinnules bearing it is small, not more than five or six on each arm. The overlap of the arm-joints also is less marked. While resembling one another in their differences from the type, these two individuals from Solor are nevertheless very unlike.

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1) Journ. Anat. and Physiol. X. 1876, pp. 581, 582; XI, 1877, pp. 90, 91.

The smaller one has stiff pinnules which are not well clothed with perisome, while in the other which is but little larger the pinnules of the lower and middle parts of the arm are stout and fleshy, very much as in one of the Ubay varieties of the Philippine series.

The mouth too does not occupy its usual interradial position, and the anus is not quite in the centre of the disc. The arms of both individuals though all grooved, are dimorphic, the posterior ones being shorter and tapering more rapidly.

The Museum contains yet another example of this species. It is a small and immature specimen collected by Hoedt on the south coast of Ceram. The distichal and second brachial pinnules are relatively rather large, the latter being considerably longer than its successor on the third brachial which may be the smallest pinnule on the arm. The overlap of the arm-joints is also but slightly marked.

To this species I would also refer a small 20-armed specimen brought to the Berlin Museum by Prof. von Martens from Kupang, Timor. It is peculiar for the small size of the pinnule on the fourth brachial which is less than half the length of that on the second brachial.

17. ***Actinometra alternans***, n. sp.

Description of an individual.

Centrodorsal a pentagonal disc slightly hollowed in the centre, with its angles produced into five blunt processes which are separated from the radials by the outer ends of the basal rays. No cirrhi nor any distinct traces of functional cirrhus-sockets. First radials short, below the level of the centrodorsal but not separated from it by distinct clefts; the second much longer and wider, broadly hexagonal, and partly united laterally; axillaries barely half as long again, almost triangular with very open angles. Numerous arms of 150 + joints.

The rays are quite free from the second radials onwards and may divide five or rarely six times, the successive divisions consisting alternately of three joints with the axillary a syzygy, and two joints without a syzygy. The first joints after each axillary quite free or but slightly united laterally. First two brachials about equal in length, nearly oblong; the third (syzygy) longer with its terminal faces sloping obliquely inwards so that the outer side is the longer; the next few joints shorter and bluntly wedgeshaped. The following ones are longer again, more sharply wedgeshaped and overlapping, with slight spines on their distal edges. The overlap is sometimes so marked that the joints seem to have a sharp dorsal keel with spiny edges. After about the 30th joint they are shorter, blunter and more oblong, becoming squarer and less strongly overlapping towards the arm-ends.

First syzygium on 3rd brachial; the next between 12 and 17; then an interval of 3 or 4 joints between successive syzygia.

The second joints after the first (radial), and third (palmar), axillaries bear slender pinnules of moderate length, the first of which is slightly the longer. The next pinnule which is on the second brachial (except when there is a sixth ray-division) is a good deal shorter, and that on the fourth joint still more so. The next six or eight pinnules (5 to 10 or 12 br.) are a little longer, consisting of 15 more massive joints, the lower ones of which are trapezoidal with their outer distal angles produced into short processes. The following pinnules become gradually longer and more slender, composed of longer joints still retaining processes on their outer sides and fringed with small spines. The lower pinnules as far as the 4th brachial have a small terminal comb, which occurs also on some of the larger pinnules immediately following.

Disc lost; diameter across the radials 13 mm.

Spread about 25 centim.

Colour blackish brown. Locality unknown.

Remarks. The specimen described above is a somewhat mutilated one belonging to a type which is entirely different from any hitherto described, and at the same time rather rare. I only know of two other species which present the same curious alternation in the number of joints in the successive arm-divisions.

It is also interesting as showing a stage in the metamorphosis of the centrodorsal which is less advanced than that exhibited by *Actinometra typica.* As in that type the ends of the basal rays are visible externally. The nearest ally of this species is one discovered by Prof. Semper at Pandan near Bohol in the Philippine Islands. It has a thin stellate centrodorsal with traces of cirrhus-sockets still visible, but the joints of the arms and pinnules are quite smooth, and there is no sudden increase in the width of the pinnule joints on the lower parts of the arms, while all the lower pinnules are stouter and more fleshy than in *Act. alternans.*

18. ***Actinometra Schlegelii***, n. sp.

Description of an individual.

Centrodorsal a thin circular disc, hollowed in the centre and bearing about 20 marginal cirrhus-sockets. Cirrhi lost. First radials almost entirely concealed except for their angles which are rounded, thickened and turned upwards so as to rise somewhat above the level of the rest of the calyx 1). Their distal edges are incurved to receive the convex proximal edges of the trapezoidal second radials which are closely united laterally. Axillaries short, barely half as long again as the second radials, widely triangular and in contact laterally. More than 80 arms, the rays dividing five times; each division of three joints the axillary with a syzygy. Rays and their subdivisions somewhat closely united by plated perisome as far as the palmar

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1) The mouth is supposed to be downwards and the dorsal surface upwards.

axillaries, and the apposed sides of contiguous joints are flattened laterally. First joints after each axillary closely united laterally, and the second ones but little separated. First two brachials wide and about equal in length, the second being the more wedgeshaped.

The next two or three joints roughly oblong, and the following ones wide, wedgeshaped, and strongly overlapping, their distal edges being much raised. Arms dimorphic. In the long slowly tapering anterior ones of 150 + joints the joints are wedgeshaped till quite near the end, the later ones being relatively shorter, blunter, and smoother, and the terminal ones squarer elongating just at the end. The posterior arms taper much more rapidly and end after about 120 joints, those of the latter third being very bluntly wedgeshaped and the terminal ones squarer.

First syzygium on 3rd brachial; the next from 9—13 usually on 10 or 11; then an interval of 1—5, usually 3, joints between successive syzygia.

Second joints of all the ray divisions have long and fairly stout pinnules, decreasing rather rapidly to that on the 4th brachial, which is not, however, specially short or slender. The following ones considerably stouter and gradually increasing in length, but decreasing in stoutness after about the 25th joint. Terminal pinnules slender but not unusually long, especially in the posterior arms. The large basal joints of the stout lower pinnules slightly overlap one another; and the lowest pinnules have a moderate terminal comb which disappears after about the 8th brachial. Disc lost; several ungrooved arms. Diameter across the radials 14 mm. Spread probably about 25 centim.

Colour, skeleton brownish white, the perisome darker.

Locality, East Indies?

Remarks. I have much pleasure in connecting this fine species with the name of Professor Schlegel, the accomplished director of the Leyden Museum. Its specially distinctive character is the peculiarity presented by the first radials, which are flush with the second along the middle line, but are thickened and turned upwards at the angles which appear as five small tubercles around the edge of the centrodorsal. It also differs from *Act. Bennetti* which has a much larger number of cirrhi, in the rays and their subdivisions being more closely united, the arm-joints less spiny, and the lower pinnules more massive.

19. ***Actinometra Bennetti***, Mus. Leyd. sp.

1841. *Alecto Bennetti*, Müller. Monatsbericht d. Berlin. Akad. 1841. p. 187. Wiegman's Archiv. 1841. I. p. 146.
1849. *Comatula Bennetti*, Müller. Abhandl. d. Berlin. Akad. 1849. p. 264.
1862. *Comatula Bennetti*, Dujardin. Hist. nat. des Zoophytes. Echinodermes, p. 208.
1866. *Actinometra Bennetti*, Böhlsche. Wiegman's Archiv. 1866. I. p. 90.
1879. *Actinometra Bennetti*, P. H. Carpenter. Trans. Linn. Soc., Ser. 2. Zool. II. p. 27.

Centrodorsal large, convex, hollowed in the centre, with two or three irregular rows of cirrhus-sockets on its sides, and its angles produced into short processes above which the ends of the basal rays are sometimes visible Cirrhi 40—50, of about 25 rather stout joints: the fifth or sixth is slightly longer than broad, the next three or four slightly the longest and the following ones decreasing very gradually, nearly all of them being longer than broad. The terminal joints are slightly compressed and the penultimate has a very faint opposing spine. Portions of the first radials are just visible at the angles of the calyx: the second, which are partially concealed by the large centrodorsal have curved proximal edges and are more or less united laterally; the axillaries broadly pentagonal, with incurved distal edges. 70—80 arms, the rays dividing four or sometimes five times. Each division of three joints, the axillary with a syzygy. The perisome uniting the rays and their divisions, is more or less plated as far as the third (palmar) axillaries. Arms of 100 + joints. First brachials large, partly united with their fellows, and not quite oblong, their outer sides being slightly the longer: second joints somewhat shorter and more oblong; third (syzygy) square or just longer than wide. The next four or five joints are transversely oblong, their hinder edges having slight backward projections alternately on opposite sides, the following joints longer, rather sharply wedgeshaped, and overlapping with spiny distal edges. Those after the 40th become shorter, blunter, and more oblong and overlap less distinctly.

First syzygium on 3rd brachial; the next between 15 and 18; (17—38, Böhlsche) then an interval of 2—5 (7, Böhlsche) joints, usually 3 or 4 between successive syzygia.

The second joints of the arm-divisions bear long pinnules; the first two are nearly equal, of 70 joints and nearly 30 mm. in length. The size decreases to that on the second brachial which is not quite half as long as the first (distichal) pinnule. The next five or six decrease rather more rapidly and the following ones increase again. The pinnules as far as the third or fourth brachial have very strong blunt processes on their last 12 or 15 joints; in the next six or eight joints the terminal comb becomes less and less prominent and finally disappears altogether.

Mouth, radial or nearly so; all the arms grooved. A few calcareous granules on the disc, especially round the anal-tube. Diameter of disc 30—35 mm.

Spread about 28 centim. Colour brown or reddish brown.

Locality unknown. Coll. Bennett.

Remarks. The two specimens on which the above description is based and which were examined by Troschel for Müller, are both considerably mutilated. They differ slightly in the number of cirrhi borne by the centrodorsal and in the extent of its cirrhus-free surface; also in the development of spines upon the arm-joints, and in the extent to which the perisome is plated between the rays.

Müller's description of these two specimens differs somewhat from that given above, as he speaks of every fourth joint in the arm-divisons as being an axillary without a syzygium. There are, it is true, four joints, but the last two of these are united by syzygy as in *Act. japonica* and *Act. parvicirra*. Böhlsche[1]) has already pointed out this mistake of Müller (i. e. of Troschel's) when describing an individual from the Loyalty Islands in the Zoological Museum at Göttingen. There is a similar one from the same neighbourhood (Uea) in the Natural History Museum at Stuttgart, and another from the Pelew Islands in the University Museum at Copenhagen.

20. ***Actinometra Peronii***, n. sp.

1816. *Comatula multiradiata*, Lamarck (in part). Syst. d'Anim. sans Vert. II, p. 534.
1834. *Comatula multiradiata*, de Blainville (in part). Manuel d'Actinologie. p. 249.
1849. *Comatula* (*Alecto*) *multiradiata*, Müller (in part). Abhandl. d. Berlin. Akad. 1849, p. 261.
1862. *Actinometra multiradiata*, Dujardin (in part). Hist. Nat. des Zoophytes. Echinodermes. p. 210.

Description of an individual.

Centrodorsal a convex disc somewhat hollowed in the centre. Cirrhi 25—30, in two rows, stout and long (sometimes 40 mm.) and composed of about 30 tolerably uniform joints. The joints increase in length up to about the sixth and then slowly diminish, the later ones being somewhat compressed laterally and the penultimate having a faint opposing spine. First radials only visible at the angles where small basals appear; the second planoconvex, barely meeting laterally. Axillaries widely pentagonal with rather sharp distal angles. 66 arms, the rays dividing three or occasionally four times; each division of three joints, the axillary a syzygy. First distichals very slightly united laterally, the first joints after the other axillaries rather more closely so. Rays well separated, the perisome between them and that between their first divisions covered with minute plates.

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[1]) Wiegman's Archiv. 1866. I. p. 90.

Arms of 150—200 joints, the anterior ones slightly the longer. First two brachials somewhat variable in shape, the first being rather the longer. The third (syzygy) short, oblong or nearly square. The next five or six joints nearly oblong, the following ones gradually becoming short and sharply wedgeshaped with slightly raised distal edges. Towards the middle of the arm the joints are shorter and blunter, with finely denticulate edges, and the terminal ones are oblong or nearly square. The distal margins of most of the arm-joints have pointed forward projections alternately on opposite sides.

First syzygium on 3rd brachial: the next from 19—25; then an interval of 3—9, usually 3 or 4, joints between successive syzygia.

The second joints of the arm-divisions bear long pinnules; the first two are tolerably equal, 30 mm. long, with large basal joints. The size decreases rapidly to about the 8th brachial, after which the pinnules are uniform in length for a few joints but gradually become stouter; the following ones slowly increase in length to near the end of the arm, but are always much shorter than the lowest pinnules. These bear a well marked terminal comb which disappears after about the 10th brachial.

The mouth has no very definite position; between it and the anus are a few calcareous granules.

Diameter of disc 35 mm. Spread about 25 centim.

Colour light brown.

Locality. The South coast of Ceram. Coll. Hoedt.

Remarks. I believe this fine specimen to be identical with two others in the Bonn and Paris Museums respectively, which were described by Müller along with another quite distinct type under the name *Comatula multiradiata* Müll. This specific name was first employed by Linnaeus for various *Comatulae* (including one in the Retzian collection) which he described, together with the other Starfishes, under the common name *Asterias* [1]). Lamarck [2]) also employed it to designate some many-armed *Comatulae* from the voyage of Peron and Lesueur in 1803; and a remarkable specimen in the Bonn Museum was referred to the same type by Goldfuss [3]) who afterwards dissected it. This, however, may be left out of consideration altogether as no example presenting such very remarkable peculiarities as were described by Goldfuss has been met with during the last fifty years, and his type is now generally known by the name *Comaster* [4]).

The name *multiradiata* is such an exceedingly natural one for a many-armed *Comatula*, that its very general application to any type with more than ten arms is hardly to be wondered at, and the determination of its proper limits is by no means an easy process.

The first steps in this direction were taken by Müller [5]) who redescribed one of Lamarck's original specimens under the specific name *multifida*, leaving *multiradiata* for the Retzian specimen with which he grouped some *Comatulae* in the Paris Museum from the voyage of Peron and Lesueur (1803), and a fine specimen brought from the Moluccas in 1829 by Quoy and Gaimard. He also spoke of a specimen in the Bonn Museum by the same name, and said that it »stimmt auch durch den Besitz der Syzygien an den Axillaria der Arme mit *Com. multiradiata* Retz."

I have been courteously permitted to examine all these specimens at Lund, Paris, and Bonn, a privilege for which I am much indebted to Professors Quennerstedt, Perrier

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1) Systema Naturae, editio decima tertia (Lipsiae 1788), pars VI, p. 3166.
2) Système d'Animaux sans Vertèbres, 2me Ed. (Paris, 1816), Tom. II p. 534.
3) Petrefacta Germaniae, I (Dusseldorf, 1826—35), p. 202.
4) Journ. Linn. Soc. Zool. Vol. XV. pp. 454—456.
5) Abhandl. d. Berlin. Akad. 1849, pp. 261, 262, 265.

and von Troschel respectively, and I find that Müller's work may be carried a stage farther.

The Bonn specimen and a spirit one from Peron's voyage differ very considerably from the Retzian type. This resembles one of Peron's dry specimens and also that of Quoy and Gaimard from the Moluccas in having but two joints in the secondary and tertiary arms, though there are three joints in the primary arms. In the Bonn specimen on the other hand, and in one from Peron's voyage there are three joints in the secondary and tertiary as well as in the primary arms. But in both types the axillaries are always syzygial or double joints as mentioned by Müller, this being probably the cause which led him to unite them, and at the same time to separate them from Lamarck's other specimen which has no syzygies in the axillary joints (*C. multifida*).

The Leyden specimen which I have described above resembles that at Bonn and its fellow at Paris in having three joints in all the arm-divisions, and I have called it *Act. Peronii*, the Paris example of the type having been obtained in 1803 by Peron and Lesueur.

This type is very similar to *Act. Bennetti* but differs in having fewer cirrhi, and in the joints composing them being tolerably uniform in size. The arm-joints too are relatively shorter, while both the first and the subsequent syzygial intervals are longer than in *Act. Bennetti*; and the pinnules which have stouter and shorter joints are more clothed with perisome.

This specimen was the host of a *Myzostoma* which will be described by Professor Graff.